Pilot Scale Fluidized Bed Testing

The Idaho National Laboratory has a unique capability to demonstrate the viability of fluidized bed technology for a variety of applications, including radioactive and hazardous waste treatment. This capability includes two scaled-systems with supporting off-gas treatment, continuous emissions monitoring, and analytical chemistry systems.

The smaller of INL's two fluidized test bed systems is an 8-centimeter vessel contained within a laboratory hood.

Overview

The INL has 50 years of experience in performing pilot scale tests that support the design and operation of fluidized bed mixed waste treatment processes. During this time, fluidized bed calcination has been refined and used at the INL to evaporate, denitrate and solidify mixed waste and uranyl nitrate to produce a granular solid material. Waste products have less volume and are less hazardous than original wastes.

The most recent experiments and demonstrations have been performed regarding INL's traditional fluidized bed calcination to more efficiently treat mixed waste and meet new regulatory standards – and to evaluate fluidized bed steam reforming of mixed waste as an alternative to other thermal processes.

Unique Test Facilities

The INL uses two fluidized bed test systems for proof-of-concept and demonstration testing. One lab-scale 8-centimeter (3.25-inch) diameter system is located at the INL Engineering and Demonstration Facility, and a larger 15-centimeter (6-inch) diameter system is located at the Science and Technology Applications Research (STAR) Center in Idaho Falls. Subcon-tractor Science Applications International Corporation manages this facility and operates this DOE-owned system under INL's direction.

Both Facilities are permitted to process hazardous waste simulants

Both calcination and steam reforming tests using non-radioactive materials have been conducted to simulate the treatment of various mixed and radioactive waste streams – including INL's highly acidic sodium-bearing waste (SBW), Savannah River Site's salt waste, and Hanford's low-activity waste (LAW). The resulting products are primarily carbonates or almininosilicates of the metal cations in the feed. The most recent steam reforming tests have demonstrated compliance with EPA's Hazardous Waste Combustor (HWC) Maximum Achievable Control Technology (MACT) regulations.

Testing Apparatus System Description

The larger pilot scale system at the STAR facility includes several primary subsystems including:

1. feed systems/equipment for gases, liquids/slurry, and small solids,

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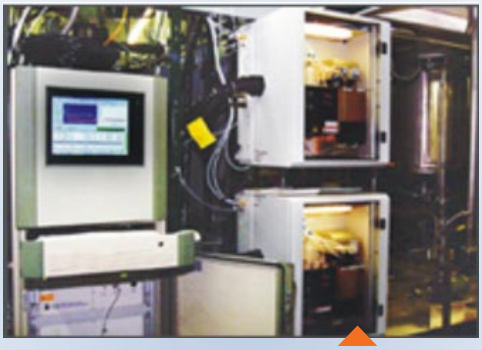
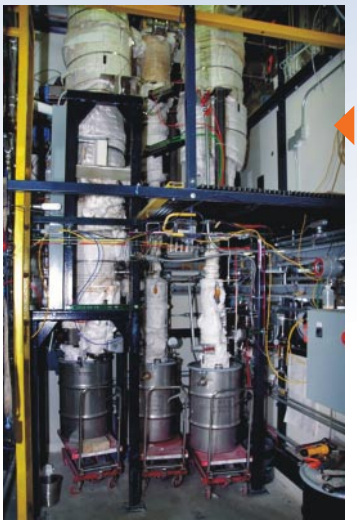
2. the fluidized bed reactor vessel consisting of the bed bottom receiver and fluidizing gas distributor section, fluidized bed section, upper larger diameter freeboard (bed particulate disengaging) section, and the vessel wall external heating system,
3. the process product/solids collection and management systems,
4. the off-gas treatment/emissions-control systems, and
5. the process monitoring and control system.

The system occupies a space of approximately 12 meters by 12 meters in area and 6 meters in height. All wetted components are constructed from corrosion resistant materials. Equipment and piping are fabricated from 300-series stainless steel except for the reformer vessel, which is fabricated from Inconel 800H. The system can be manually controlled or automatically controlled using a Process Logic Controller (PLC) system with multiple human-machine interface (HMI) stations.

The STAR Center provides for all necessary test system utilities and support services including electrical power, water, compressed air, nitrogen, oxygen, various specialty calibration gases for continuous emissions monitoring systems, test system operations, permits, and materials/waste management.



These three photos show the Hg monitoring system equipment and aspects of on-site analytical capability.



The fluidized bed system configuration, shown above, consists of the fluidized bed vessel (above the steel drum on the left side), a cyclone (located above the steel drum in the middle), and a heated sintered metal filter (above the steel drum located on the right side).

There are several available supporting off-gas treatment unit operations that include:

- Cyclone for particulate removal.
- Sintered metal filters for small particulate (2mm).
- Wet venturi scrubbing.
- A natural gas-fired thermal oxidizer for oxidation of hydrogen, carbon monoxide, methane, other hydrocarbons, and NO_x destruction.
- Mist elimination.
- Granular activated carbon filter/sorption bed.

An extremely unique feature is the continuous emissions monitoring system (CEMS). This stand-alone system is capable of sampling, conditioning, and analyzing for O_2, CO, CO_2, H_2, CH_4, NO, NO_2, HCl, SO_2, total hydrocarbons, elemental and oxidized Hg at locations of choice.

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